

Migros Cross-Math Solver

Pascal Lüscher

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1 Problem

The Cross-Math puzzle is a puzzle with 9 numbers to fill. The rules are simple:

- Mathematical operation ordering does not count, simply calc from left to right and from top to bottom
- Each cell is filled with a number between 1 - 9
- Each number can only appear once

The puzzle presented is the following:

	−		*		=	3
−		+		*		
	+		*		=	20
+		/		*		
	+		+		=	20
=		=		=		
13		1		20		

2 Mathematical formulation

2.1 With Big- M

$$\begin{aligned}
\min \quad & 0 & (1) \\
\text{s.t.} \quad & x_i & \geq 1, & \forall i \in \{1, \dots, 9\} & (2) \\
& x_i & \leq 9, & \forall i \in \{1, \dots, 9\} & (3) \\
& x_i - x_j & \leq -\epsilon + y_{i,j}M, & \forall i, j \in \{1, \dots, 9\} & (4) \\
& x_i - x_j & \geq \epsilon - (1 - y_{i,j})M, & \forall i, j \in \{1, \dots, 9\} & (5) \\
& (x_0 - x_1)x_2 & = 3 & (6) \\
& (x_3 + x_4)x_5 & = 20 & (7) \\
& x_6 + x_7 + x_8 & = 20 & (8) \\
& x_0 - x_3 + x_6 & = 13 & (9) \\
& \frac{(x_1 + x_4)}{x_7} & = 1 & (10) \\
& x_2x_5x_8 & = 20 & (11) \\
& x_i & \in \mathbb{N}, i & \forall i \in \{1, \dots, 9\} & (12) \\
& y_{i,j} & \in \{0, 1\} & \forall i, j \in \{1, \dots, 9\} & (13) \\
& & & & (14)
\end{aligned}$$

M is very big and ϵ is a very small number.

Equation 2 to Equation 5 are the basic requirements for the corss-math puzzle. Equation 6 to Equation 11 are the specific equations for this problem.

2.2 Binary variables

3 Solution

9	−	6	*	1	=	3
−		+		*		
3	+	2	*	4	=	20
+		/		*		
7	+	8	+	9	=	20
=		=		=		
13		1		20		